Research on Key Performance Evaluation Method Based on Fuzzy Analytic Hierarchy Process

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Abstract. Under the traditional performance evaluation method, the financial analysis process lays too much emphasis on the integrity and the weight of performance factors is not clear, which leads to the poor aggregation degree of performance evaluation data. A key performance evaluation method based on fuzzy analytic hierarchy process (FAHP) is proposed. The data flow of performance indicators is established according to the current situation of the enterprise on the basis of the three indicators of work efficiency of financial staff, utilization of financial funds and overall financial operation efficiency. By applying data envelopment analysis and static tree analysis, a comprehensive analysis model is established. The index data flow is sampled according to the boundary performance value and the weight of each factor is calculated by using the idea of fuzzy hierarchy. After quantification, the final fuzzy evaluation is obtained and the key performance evaluation is realized. The experimental results show that compared with the traditional key performance evaluation method, the data aggregation degree of the designed key performance evaluation method is improved by 29%, and the overall scientific nature is stronger.

Keywords: Fuzzy hierarchy · Evaluation results · Data aggregation · Sampling extraction

1 Introduction

At the beginning of reform and opening-up in the last century, China was backward in society, weak in economic foundation, low in scientific and technological level, workers'cultural literacy, backward in ideology, low in international status, less exchanges with foreign countries, lack of experience in market economy, and imperfect in various economic systems, laws and regulations. In recent years, with the stability and prosperity of China's social economy and finance, some economists in China have begun to emphasize financial economic management. The core issue is how to prepare effective financial formation management policies and how to rationally allocate existing financial resources in the financial management of enterprises in China. The

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solution of this problem has an important impact on the rational management of financial economy of enterprises in China. In order to ensure the smooth progress of the financial work of enterprises and carry out financial management with the highest efficiency, it is necessary to establish a proprietary financial key performance evaluation index system, which can not only ensure financial security, but also improve work efficiency. Facts have proved that only by using new management means to ensure the standardization of financial information management process, can the risk be minimized, some duplicate financial work content be avoided, and the efficiency of financial information management is gradually improved. The method of fuzzy analytic hierarchy process (FAHP) is to express the fuzziness of the evaluation index on the impact degree of the final evaluation target parameters in the form of a fuzzy set, form an evaluation matrix that can be directly evaluated, and obtain the evaluation result of a fuzzy set through a fuzzy transformation, and evaluate the final evaluation target parameters according to the size of membership. By introducing the Fuzzy Analytic Hierarchy Process (FAHP) evaluation scheme, we can establish a unique evaluation matrix through the objective weight of the indicators, and realize the evaluation of key financial performance [1].

2 Design of Key Performance Evaluation Method

2.1 Establishment of Performance Indicators Data Flow

The extraction and establishment of financial key performance data flow can be simply regarded as a combination of organizational viewpoints and thinking modes of financial sharing. The organization of data viewpoint is the primary problem in designing an effective method of financial key performance evaluation. It needs to use mathematical logic to influence data system integration. Through the follow-up Fuzzy Analytic Hierarchy Process (FAHP), an analysis matrix is established for comprehensive calculation.

In the establishment of data flow of financial performance indicators, different levels of financial information need to correspond to different value systems and financial advantages, and finally introduce different rating weights. The whole data system of performance indicators is divided into policy level and strategy level according to the level of financial information. Its core indicators include three main aspects: the efficiency of financial personnel, the utilization rate of financial funds, and the overall operational efficiency of finance [2].

The work efficiency of financial personnel needs to be determined by means of per capita financial operation quota. Its algorithm is the ratio of the total operation quota to the total number of financial personnel. This value reflects the intrinsic relationship between human resources input and output. The larger the ratio, the stronger the purchasing economy. In addition, it is necessary to determine the value of the per capita procurement cost, that is, the ratio of the average monthly salary of the procurement personnel to the public financial expenses of the procurement department. The smaller the ratio, the higher the procurement efficiency of the procurement department.

The determination of the index of the utilization rate of financial funds needs the support of three data: budget preparation rate, procurement budget completion rate and procurement control rate. Budget preparation rate is the proportion of purchasing funds to the overall budget, which reflects the efficiency of purchasing departments' management of financial funds. The procurement budget completion rate is the ratio of the procurement amount to the procurement budget. This ratio defines the effect of the procurement budget implementation. The higher the proportion, the more efficient the financial budget implementation is, and the better the procurement goal can be achieved. Purchasing control rate can reflect the degree of capital savings of purchasing department. However, high control rate is not the ultimate goal in procurement, because the accuracy of procurement budget preparation and budget precision can also determine the control rate to a certain extent [3].

The overall operational efficiency of finance is the proportion of enterprise financial expenditure in the total amount. On the one hand, this proportion shows the importance of financial application of enterprises, on the other hand, it also reflects the impact of economic operation of enterprises. Under certain conditions of the overall budget, the larger the ratio, the smaller the corresponding proportion of other forms of economic management. Detailed economic indicators are as follows: Table 1:

Table 1. Factor analysis table

Level	Scope	Status quo	Methods
Policy level	Organizational model	Risk analysis	Performance improvement
	Financial facilitation	Project performance status	Economic project data
	Financial missiveness	Improve potential	Project execution data
	Financial internal information division	Comprehensive risk	Economic data
	Overall financial information standards	In-project roles	Economic planning data
Strategic level	Mission of the position	Financial situation	Data system
	The main duties and responsibilities	Performance improvement	Training design
	Economic enforcement conditions	Economic information analysis	Incentive plan
	Economic punishment data	Regional economic data	Factors data
	Economic analysis data	Positive data	Choose the part of data
	Economic development data	Negative data	New member data

The above-mentioned evaluation index system mainly aims at the actual evaluation scheme of current enterprise financial performance index data flow. Through evaluation and analysis, numerous data streams can be formed, which can provide data base for subsequent data sampling and extraction [4].

2.2 Indicator Data Flow Sampling

The establishment of data flow in cloud Accounting Financial Sharing Center needs to aim at the completion rate of the above evaluation indexes and influencing factors. The actual calculation of data flow needs to consider many reasons. After the data flow summary work is completed, we can extract the data indicators samples of the current key data of enterprise finance through the designed extraction template. In order to ensure the scientificity and accuracy of data extraction, the design introduces two kinds of data logic analysis methods: data envelopment analysis and static tree analysis, and combines the current financial indicator data for theoretical quantification [5].

Data Envelopment Analysis (DEA) is a comprehensive logical structure analysis method derived from the intersection of modern financial operations management and mathematical economics. It is mainly through the use of mathematical logic planning to convert multiple evaluation indicators or data flow information into output departments or units (also collectively referred to as decision units), and then judge whether each decision unit is DEA according to the effectiveness between each decision unit. Effective, in simple terms, is to analyze whether each decision-making unit is in efficient production, and its effective data is extractable data.

In the field of statistics and financial economics, efficient production is a prerequisite for generating production functions. DEA method can be used to determine the distribution structure of integrated production frontiers, so DEA can also be regarded as an unconventional parametric statistical evaluation method. Because there are many decision-making units involved, the designed analysis model introduces the static tree structure into the DEA data envelopment analysis method, and establishes a static tree analysis system, as shown in Fig. 1:

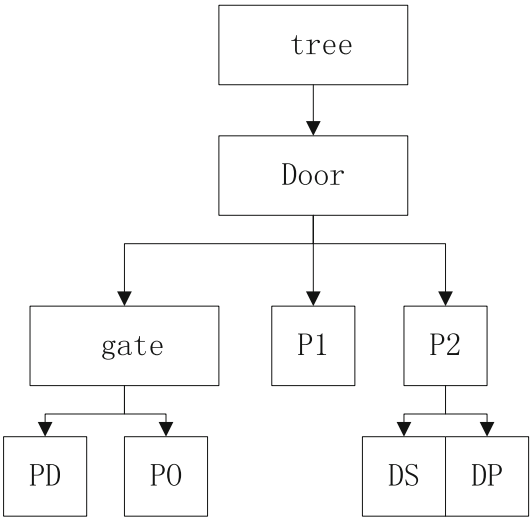

Fig. 1. Schematic diagram of static tree analysis

The static tree analysis method can use the linear specification to obtain the production frontier boundary of each economic data analysis gate of the current enterprise, and directly calculate the completion efficiency and input and output of the decision unit under each gate. In the actual calculation, the decision unit should be comprehensively selected first, the total number is N; m and S respectively refer to the performance rate input and output of each decision unit, and assume the ith input variable of the Kth decision unit, denoted by the symbol Xik (i = 1, 2, … m), corresponding to the Jth output in this series of decision units expressed by Yjk (i = 1, 2, … s), relevant The calculation model is as follows:

$$s,\mathrm{t}\left\{\begin{array}{c}\sum_{k=1}^{n} X_k H_k + s^- = \theta X_\mathrm{t} \\ \sum_{k=1}^{n} X_k H_k - S^+ = Y_\mathrm{t} \\ s^- \geq 0,\ s^+ \geq 0,\ H_k \geq 0,\ k = 1,2,\ \ldots \mathrm{n}\end{array}\right\} \tag{1}$$

In Eq. 1, s^- and s^+ respectively represent the economic verification coefficients of each decision gate; H and θ represent the decision-making influence parameter variables of each decision gate; where θ is the performance comprehensive efficiency value of each financial information influence gate [6].

The efficiency obtained by formula (1) can be represented by λ. In order to distinguish the value range, each part of the value range can be divided into: A1, A2, A3, A4. In performance rating, the theoretical efficiency is assumed to be a fixed amount, then each range variable and corresponding output are:

$$A_1 = A_2 = A_3 = A_4 = 3.5 \times 10^{-8} \tag{2}$$

$$U_1 = U_2 = U_3 = U_4 = \frac{1}{4}H \tag{3}$$

Where H is the Solomon efficiency coefficient and is based on the actual situation.

Before the calculation, the static tree analysis can be transformed into a static analysis chain, and the data extraction convenience rate is improved as shown in Fig. 2.

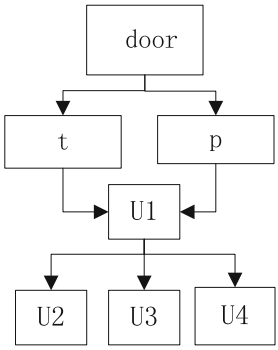

Fig. 2. Static tree analysis chain

Based on Fig. 2 and Eqs. (2) and (3), the decision-making unit input and output analysis matrix is established to obtain the boundary performance value C [7].

$$C = \begin{bmatrix} -(U_1 + A_1) & A_1 & A_2 & 0 & 0 \\ U_1 & -(U_1 + A_2) & 0 & U_2 & U_3 \\ U_1 & 0 & -(U_1 + A_3) & 0 & 0 \\ 0 & U_2 & 0 & -(U_1 + A_4) & U_4 \\ 0 & 0 & U_4 & 0 & -(U_2 + A_1) \end{bmatrix} \tag{4}$$

The boundary performance value can represent the completion efficiency of each desired work within the indicator system. Using DEA analysis, the input and output values of all decision units are converted to boundary performance values, projected into the geometric space, with the lowest input or highest output as the boundary [8, 9]. When the decision-making unit (DMU)'s boundary performance refers to being at the spatial boundary, the DMU is considered to be efficient and efficient, with a relative efficiency value of 1, which means that the DMU can no longer reduce input or increase production under the same conditions. The data is extractable data. If the DMU is within the bounds, the DMU is an inefficient unit and gives a value between 0 and 1. The performance metric between 1 indicates that if the output is unchanged, the input or investment remains unchanged. It shows that if you continue to add inputs, you can increase the output, and the data is non-extractable data [10].

2.3 Achieve Performance Evaluation

According to the sampled data extracted above, based on the fuzzy analytic hierarchy process, the final performance target can be evaluated. The principle steps are as follows:

A set of factors U composed of factors to be evaluated that affect the set of evaluation results of the target and a set of comments v composed of comments that judge each factor are set. Can be expressed as:

$$\begin{aligned} U &= (u_1, u_2, \cdots u_n) \\ V &= (v_1, v_2, \cdots v_n) \end{aligned} \tag{5}$$

Firstly, according to the 1:1 analytical method of the analytic hierarchy method, according to the evaluation method shown in Table 2, all the factors in the factor set U that affect the financial performance are compared in pairs, and the fuzzy quantitative assignment between the influencing factors is established [9].

Table 2. Fuzzy weighting method for each evaluation factor weight

The importance of the factors x, y	f(x,y) assignment	f(x,y) assignment
Equally important	1	1
X is slightly important	3	1/3
X is important	5	1/5
X is very important	7	1/7
X is extremely important	9	1/9

By comparing the two factors, we can get an n-direction positive matrix C. The application formula (4) of fuzzy assignment of each factor in matrix C is transformed to obtain the weight coefficient of single factor. On this basis, the weight vector composed of multi-factor weight coefficients is obtained, and the weight vector is expressed as n. Then, according to the evaluation in the single factor evaluation set v, the discretized values are applied to the normal distribution according to the grading criteria, and the fuzzy comprehensive evaluation matrix R is constructed according to the interval membership degree of the function. After determining the weight vector and the comprehensive evaluation matrix, the result of the comprehensive evaluation Y can be obtained by the fuzzy operation, where Yj is the subordinate of the corresponding fuzzy comment corresponding to the judgment object, and generally needs to analyze and evaluate the result according to the principle of maximum membership degree. It is considered to be the last fuzzy comment [11, 12].

3 Experimental Results and Analysis

The simulation data set is taken as an experimental sample to illustrate the basic process of determining the key performance value by applying fuzzy comprehensive evaluation method and verifying the rationality of the method. Applying the 1–9 ratio method, according to the relative importance of different factors to evaluate the target parameters, the fuzzy assignment is performed, and the normalization transformation is applied to determine the single factor index weight coefficient. For example, the evaluation of the efficiency of financial application, the main factors affecting the financial structure, the status quo of enterprises. According to the factors, the two factors are compared to determine the importance of the factors.

Commonly used, good, medium, poor, and poor five-level evaluation criteria to fuzzy evaluation of a good or bad thing. The calculation method and evaluation standard of single factor index in the evaluation system are mainly determined based on the results of ministerial standards and digital model theory. For example, the plane permeability coefficient of variation coefficient is good, good, medium, poor, and the corresponding range is less than 0.5 0.5–0.6 0.6–0.7 0.7–0. 8 and greater than 0.8. You can directly seat the number according to the size of the parameter. For the criteria of new fiscal factors, irregular factors and other indicators, the application of mathematical model theory is determined. If the fund utilization rate standard is determined, the typical theoretical model established by the application simulates the influence degree of different capital utilization efficiency, and the five-level evaluation standard is established according to the simulation result. The end evaluation index in the evaluation system has a clear boundary value, and the single factor evaluation matrix can be obtained according to the specific value of the parameter and the single factor evaluation standard, and the normal distribution function is used to obtain the interval membership degree. The upper level does not have an explicit evaluation index of the boundary value, and the single factor evaluation matrix can be obtained by using the one-factor evaluation matrix of the next-level evaluation index and the weighting set determined by the analytic hierarchy process. On the basis of the single factor evaluation matrix, the fuzzy evaluation matrix of each level can be obtained. The matrix values are extracted to determine the final fuzzy evaluation results, which are compared with the traditional performance analysis methods. The results are shown in Fig. 3.

As can be seen from the experimental results in Fig. 3, the data aggregation degree of both the traditional method and the proposed method fluctuated to a certain extent during the whole experimental process. However, in terms of the average degree of perfect fit, the proposed method is significantly higher than the traditional method, with the highest data aggregation index value up to 0.026, indicating that the proposed method has better application effect and obvious advantages.

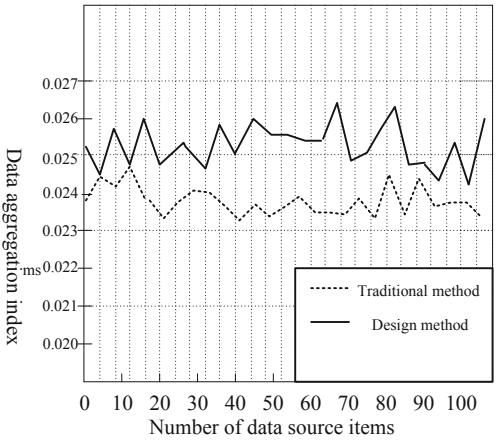

Fig. 3. Data aggregation degree comparison chart

4 Conclusion

Combining with the actual financial characteristics and the important problems faced by the authentic company, this paper applies the research template of the Fuzzy Analytic Hierarchy Process (FAHP) to make up for the influence of financial factors neglected in the past financial performance evaluation on the results of performance evaluation, and constructs a scientific, reasonable and comprehensive financial performance evaluation system of the company. This paper also has some limitations. Firstly, the data of financial indicators selected in this paper come from the current stage of our country. Although financial audit and performance evaluation need to audit the annual report of the company, the assurance provided by auditor is limited to reasonable assurance, so it is impossible to guarantee the authenticity and integrity of the annual report disclosure data 100%. Secondly, the selection and revision of the index system in this paper combines the analysis and judgment of the characteristics of the current financial enterprises. It has certain subjectivity. Different evaluation subjects may have different opinions on the selection and revision of the index. To some extent, the conclusion of this study is not unique. Finally, because the change of external environment will affect the performance evaluation system of enterprises, and the conclusion of this paper is based on the historical data disclosed in the annual reports of listed companies from 2014 to 2016, so it reflects the past financial performance performance, and fails to accurately predict the future development trend of financial performance of Listed Companies in construction industry. It is hoped that in the follow-up study, we can pay attention to the changes of the external environment and adjust the evaluation system appropriately to adapt to the new situation of industry development.

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